Future Perspectives on Product Data Management in Building Information Modeling

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Abstract

Purpose – It has been argued that product data libraries have the potential to improve global real-estate development and increase productivity. Product data libraries provide the basis to support diverse national classification systems and different languages. The aim of this paper is to identify PDM systematics and recommend future development needs to building product libraries, focusing on the functional shortcomings and data processing deficiencies found in current libraries.

Design/methodology/approach – A literature review of state-of-the-art practices of BIM within the construction industry was conducted including product libraries, supply chains, guidelines, industry tools and practices, and general use of BIM. Findings from the literature review were complemented with insights from the academia and industry by obtaining data through focused questionnaires conducted in spring 2011 with experts who were chosen based on their prestige and reference.

Findings – As a result of the studies performed for this article, roadmaps are proposed for product library implementation globally. The role of standardisation in implementing BIM-compatible product libraries is highlighted.

Originality/value – This article covers the state-of-the-art practices of product data management in BIM libraries, which is useful for the development of coherent BIM libraries for the AEC industry worldwide.

Keywords: Building Information Management, Supply Chain Management, Product Information, Data Collection, Product Library

Article Classification: Conceptual paper

Introduction

This paper reviews Product Data Management (PDM) methods and product library features. The research behind this paper aims to analyse design libraries and data exchange with the following research question: how advanced companies use product information and what research the international academia is conducting on the subject? The analysis is based on identified PDM methods, which are generic product data definitions; generic requirements and the collection of as-built product data. Trends and risks related to the use of BIM in the management of product information were identified based on questionnaire answers from distinguished experts. The current use of BIM often focuses on the production and coordination of design information. The use of BIM in the management of product information is not common and in many aspects not well known (Taylor and Bernstein, 2009; East, 2011). This paper concentrates on identifying gaps and issues related to the usability of product libraries and discuss the trends and risks concerning their development.

Several research and development projects in co-operation with the construction industry have strived to deliver coherent product libraries for the past decade. The present product libraries are still software-specific ad hoc product applications. The need for open standard product libraries is apparent on a global level. The current use of BIM often focuses on the production and coordination of design information, although it is said that BIM will bring benefits to the whole value chain throughout the building life cycle. Coherent product libraries could help establish viable new services and better building products.

The first challenge of developing coherent product libraries is related to the standardisation of data structures and data content. There are a vast number of product categories in the building industry. The second challenge is commercial. Building product manufacturers are not interested in developing extensive library information unless it is a viable business case for them, the critical mass of data in a neutral format. Shared product data also need to be feasible in design software, Material Requirements Planning (MRP) applications, and Facility Management (FM) applications.

Literature review

Status of BIM usage in product data management

The use of BIM provides new possibilities for more systematic project information management because of the structured data content (Hallberg and Tarandi, 2011). The focus of BIM-based Supply Chain Management (SCM) has mainly been on managing design and construction processes. The integrated use of BIM in sub-contracting and delivering as-built information for the FM and maintenance operations is clearly less common (AIA, 2007). However, leading construction companies are very advanced in the use of BIM.

Based on experiences and different discussions with experts, it seems relatively difficult to obtain any detailed information of the best practices. Most of the available information supports the use of BIM for marketing purposes rather than for technical level needs. It is clear that the leading edge companies see the use of BIM as a valuable benefit (Koch and Firmenich, 2011). Due to the competitive advantage, the companies do not want to share too many details with their competitors. It is apparent that the limiting factor of BIM-based SCM is not the lack of technology but the lack of BIM knowledge and skills, irregular working methods, old business processes and complicated contracts (Maher, *et al.*, 2010).

Leading building contractors use BIM in their bidding and procurement processes (Skanska, 2010; Vinci Construction, 2012; Bouygues, 2013). Further development of capitalising on BIM is in progress in several projects and countries. As an example, in ambitious projects in Finland, the design teams are obligated to hand over BIM from the design stage to the contractors who can then use the models in their bidding and procurement process. In the same manner, in the US many mechanical, electrical and plumbing (MEP) subcontractors are now delivering BIM in-house and general contractors are increasingly making BIM deliverables as a part of the bid and procurement requirements for their sub-contractors.

Regardless of several efforts in the past, typical project appointments are still built around traditional deliverables. Data are transferred via 2D-CAD, paper documents, reports, and written specifications. The

issue of exchanging detailed product data through BIM is not commonly addressed due to the slow transition of the traditional information exchange process. Often, a version of BIM is passed downstream to the contractor. The contractor then caveats to ensure that the information is not taken in preference to the traditional deliverables. Generally, contractors prefer to receive generic product information in models to ensure their ability to tender for the cheapest equipment without undue influence from the designers.

Existing product libraries

There has been growing demand for more advanced and comprehensive object libraries and modelling capabilities in computer packages. Research results suggest that available BIM technologies can improve work processes (McKinney and Fischer, 1998; Jongeling, *et al.*, 2008; Peterson, *et al.*, 2011); however, the lack of tools supporting Industry Foundation Classes (IFC) data exchange and integration of workflow between different project phases is a major concern.

Applications need support from coherent product libraries to cope with the demands of better workflow. Integration into continuous processes becomes possible as the BIM software and object libraries develop better data exchange between applications. The problem of incoherent data content can be solved by introducing templates for library objects, generic library objects and product library objects. The templates can also be used for sharing structured product data that can be used in BIM authoring and specification authoring tools. OpenBIM formats could contain accurate parametric capability, enabling cross-platform sharing.

In general, current product information is provided in proprietary data formats or a format that is only viewable, e.g. PDF format. The idea of OpenBIM library templates confronts the issues of proprietary formats and a lack of consistency in naming attributes, value ranges, etc. Libraries aimed at serving contractors and facility managers rather than just designers bring more useful information to the BIM-based building of life cycle management. By using OpenBIM libraries, the users do not have to struggle with compatibility issues and alternate between libraries produced by vendors, manufacturers and third-party organisations. Libraries based on open data formats, proper content and integration into different BIM-based designs, procurement and cost engineering applications would bring much needed help to exchanging and using information from the libraries directly in design, construction and FM processes.

A wide range of product libraries is currently available for various user groups. The available product libraries range from manufacturer-specific ad hoc libraries to open industry-wide forums that provide both objects and support. The expert forums offer various data for construction projects, plans and specifications, as well as information on market trends, in addition to product data. There is rapid growth in the number of software systems and technologies supported by the libraries, however only seldom product libraries provide IFC-compatible library objects. The lack of IFC compatibility means that the data can only be integrated with specific software that accepts their formats. This can be found to be limiting from a project data-flow point of view.

Online product data services are efficient tools for the AEC industry to share and exchange data. The object intelligence concept of building information modelling has developed links and relations between object attributes and properties (Gu and London, 2010). The most important feature implemented in the newest product libraries is their support for modelling constraints (Lee, *et al.*, 2007), which enables development of tools for tasks that are trivial but very time-consuming. New features in design tools enable more efficient energy analysis and environmental simulation, as well as automation of procurement processes. The development of product libraries needs to focus on how to support these processes. Product data could be integrated into as-built data while enabling building life cycle planning with building information models.

Development of product libraries

Product libraries are a nascent tool for the AEC industry but some methods and systems for life cycle product data management do exist: IFC is designed to provide the basis for supporting diverse national classification systems and different languages in product libraries. BuildingSMART Data Dictionary (bSDD),

formerly known as International Framework for Dictionaries (IFD), is a standard for terminology libraries or ontologies, and a representation of the object classes and their relationships.

The concept for the bSDD Library is derived from internationally accepted open standards that have been developed by ISO 12006-3:2007 (BuildingSMART, 2011). The bSDD Library provides flexibility for IFC-based BIM, allowing linkage between a model and various databases with project- specific and product-specific data. However, to be useful, bSDD needs relevant content and applications that can access and use that content. For mass use, bSDD needs to be embedded in applications that can access and exchange building information. The IFD Library 2010 Annual Report states that the IFD Library Group focuses on continuing to integrate into buildingSMART International. Emphasis is put on expanding participation in the IFD Group as well as gaining use of bSDD in pilot projects and commercial applications (Grant, 2011).

Research methodology

From an ontological perspective (Guba and Lincoln, 1989), the research seeks to contribute to revealing the structure of the reality of BIM based product data management. This was investigated through literature review addressing the research question "what opportunities do technology and processes enable in BIM based product data management at the moment". It is not the intention to assert that the literature review findings present a structure of reality that exists fully independently of humans' knowledge and social constructions of it. However, factors that are found to be common across the literature can offer some independence from individual constructions of reality because, for instance, a variety of research methods have been used in a variety of different settings by a variety of researchers.

From an epistemological perspective (Crotty, 2003) the knowledge constructed by practitioners was investigated by self-completion questionnaire addressing the research question "what direction should international research and development be directed in order to develop BIM technology to support product data management". Regarding the epistemological viewpoint of our research findings from literature review and self-completed questionnaire can provide a contribution to describe the broader reality and the emerging perceptions of BIM technology related to product data management.

A mixed methodology (Creswell, 2012) was used because more than one analytic interest was pursued; as stated above, the ontological and the epistemological. Use of mixed methodology allowed advancing broader reality and the emerging perceptions of BIM technology related to product data management.

Convenience sample was used as the sampling strategy because of its advantages in availability and the quickness with which data can be gathered. This can be important in fields where there are rapid developments (Borg and Gall, 1989). Respondents were people who had enough knowledge to answer the questions on the questionnaire.

Research background

The purpose of this study was to explore experts' opinions about the development directions of BIM based PDM. It is recognised that using self-completion questionnaires reduces biasing error caused by the characteristics of the interviewer and the variability in interviewers' skills (Adams and Cox, 2008). Open questions allowed participants to express their thoughts in their own words and were therefore particularly valuable for gaining insight. Closed questions were used to frame responses into particular topics.

The literature review aimed to answer research questions on the use of BIM in product data management within the construction industry. The study reported in this paper relates to the UK BIM initiative. This is an initiative that has been motivated by, and informed by, earlier BIM initiatives in other countries. For example, in Finland the Confederation of Finnish Construction Industries RT initiated the ProIT development project. The ProIT was established to define a national data management approach and guidelines for the construction process based on product modelling between 2002-2006 (ProIT, 2006). For example, in the USA General Services Administration (GSA) was the first government organisation to guide the US government towards BIM and had a leading role in promoting BIM in the entire industry (National Institute of Building Sciences, 2011). The review targeted the identification of the current practices in the industry.

Self-completion questionnaires with a mixture of closed and open questions were sent to selected practitioners and researchers who were known to be active and advanced in the area of integrated BIM. The questionnaire form was structured from questions under topics about technology, processes, and international research and development, as shown in Table 1.

Table 1. Questionnaire for User Profile Designer (Engineer/Architect)

Technology and Processes Transformation of the product information available within the design phase/libraries and use of modelling guidelines in the manufacturing of commercial products: 1. Do you/your design team find any gaps or shortcomings in the structure and content of the design libraries and modelling guidelines you have used? Do you consider these specifications appropriate for supporting information exchange between project participants? 2. How do you/does your organisation define generic product information in the design phase and then facilitate transformation of this product information into a specific commercial product? Use of BIM in the bidding and procurement: 1. Do you provide data or some other support for general contractors in managing product information in their bidding or procurement processes? Are you aware of any other organisations that provide this service? Use of BIM in manufacturing design, production and management of deliveries: 1. How do you collect information and integrate the manufacturers' product information into/within the as-built model?
International Research and Development Current use of BIM in the supply chain; most significant and emerging actors on this field: 1. Do you conduct or are you aware of any research and development work related to the use of BIM in supply chain and/or product information management? Are you aware of any publications in this area? If so, please provide links. 2. Do you know/have you heard of any other organisation/group that conducts R&D work related to the use of BIM in the supply chain and/or product information management? If so, please provide links. 3. Are you aware of any case examples of the use of BIM in the supply chain and/or product information management, nationally or internationally? If so, please provide links. Dissemination of R&D knowledge and important conferences: 1. Have you participated in or contributed to any conferences that promote the latest R&D work on BIM in the supply chain and/or product information management? If so, please provide links. Future development of BIM and trends/risks of BIM 1. Do you/your organisation see any future development trends or risks of using BIM?

A total of 56 questionnaires were dispatched to a group of well-known professionals who were divided into designers (12), general contractors (11), sub-contractors or suppliers (9), owners (3) and researchers or software vendors (21). Thirteen completed answer forms were received, and 10 interviewees regretted that they did not have enough knowledge of the specific area. Ergo, the 10 people felt ineligible to respond to the questionnaire, which is illustrated in Figure 1. Response rates tend to be low in self-completed questionnaires (Adams and Cox, 2008), and the total response rate with all answers combined was 28.3%. Although the sample organisations are relatively competent in BIM compared with their competitors, due to the immature nature of BIM in the management of product information, they do not possess solid expertise in the subject.

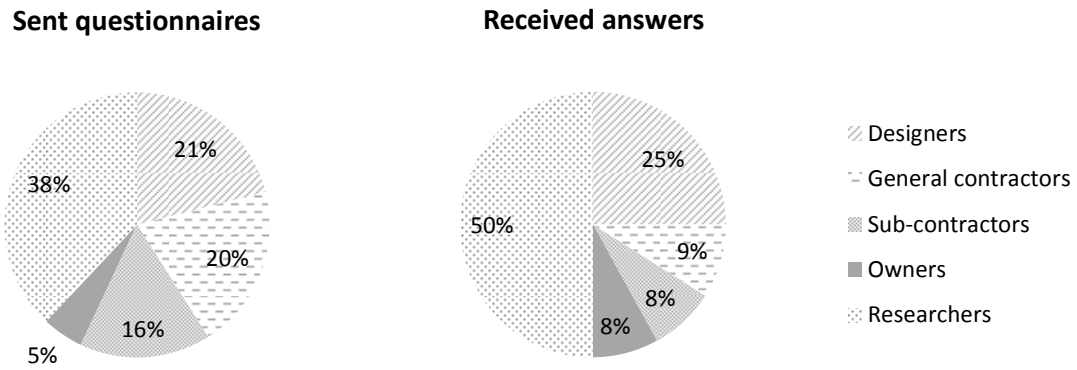

Figure 1. Sent questionnaires and relevant answers

The questionnaire revealed that at least in the focus group the objective for the construction industry is for BIM to become the mutual basis for bidding and procurement processes. BIM is becoming the support for different versions of products in all process phases. Linkage of design information and project-related requirements that the bidding and procurement options deliver increased the effectiveness and improved the quality of the final output.

All results obtained by statistical methods suffer from the disadvantage that they might have been caused by pure statistical accident. The level of statistical significance is determined by the probability that this has not, in fact, happened. It is unmistakable that the results are not statistically meaningful, but the answers reached saturation and can be seen as useful and interesting.

Presentation of findings

Identified gaps and problems

The identified gaps and problems are presented anonymously based on the questionnaire answers from distinguished experts. On a global level, no open standard design libraries are available. An interviewee states: "*Most vendors of BIM authoring tools have developed libraries in more or less ad hoc styles combining generic and product-specific information mainly from the design viewpoint, which does not serve supply chain or product information management well. The standardisation of properties and support for multiple classifications are practically non-existent*."

Most product manufacturers have not seen the market need or sufficient business justification for advanced BIM-based content creation for product libraries; an interviewee states: "*product manufacturers await high adoption rates to justify the creation of BIM-based content. Some PMs are starting to make BIM-compatible content, but this is a very small percentage of the total content*. In addition, *integration has not been prioritised in those rare cases in which product libraries exist*."

A clear methodology for incremental addition of content and data transformation from design through bidding, procurement and construction to as-built product information is missing (Owolabi, *et al.*, 2003). An interviewee states: "*Contractors need to make their supply chain content available earlier to the design team on projects as well, and understand the benefits of the process*."

Implementation of product libraries

Building materials, products and equipment have remained virtually unchanged despite the reformation of design and integration of computing technology in the construction business in the past thirty years. The buildingSMART Alliance has finished a project, *Specifiers' Properties Information Exchange* (SPIE), that aims to repurpose the way that building materials, products, and equipment are engineered, sought, specified, procured, transported, assembled, and operated (East, 2011). On a global level, open standard product

libraries await a general standard in order to better support the electronic information exchange of building products.

The existing product libraries vary greatly in their contents and support, as illustrated in Table 2. The available product libraries are not compatible with each other or the wide spectrum of different software. The construction industry is in great need of a product library standard for determining what products the product libraries should contain, what properties are required and how libraries need to be supported for multiple classification systems. With the growing interest in sustainable construction, building life cycle management needs standardised product libraries, which has already been proved among other industries (e.g., mechanical engineering) (Nummelin, *et al.*, 2011). A standard is important for generating viable new business activities with products and for launching advanced product library solutions.

Many of the existing product libraries are free to download from the Internet. The following list is by no means comprehensive but represents examples of current typical product libraries. Manufacturers that produce globally diverse products, systems and services for construction professionals offer their product data online.

Table 2. Levels of Development from Basic to Advanced Solutions

	Contents	User Group	Classification	Data Transfer
Basic Solution	Generic objects	Designers	No support	BIM/CAD No IFC support
	All manufacturers' products	Designers, contractors	Manufacturer part number	BIM/CAD, various systems No IFC support
	Generic and manufacturer objects	Designers, contractors, manufacturers, owners	No support	BIM Software-specific Cost check from quantity take-offs
	Details, specifications and building product data	Designers	CSI MasterFormat	BIM No IFC support
	Data for construction projects and product information, plans and specifications, industry news, market research and industry trends and forecasts	AEC industry as a whole (owners, designers, contractors, vendors, etc.)	CSI MasterFormat	BIM/CAD No IFC support
State-of-the-art Solution	Comprehensive generic and manufacturer-specific product data for multiple design domains	Designers, contractors, manufacturers, vendors	CSI MasterFormat 2004 CSI OmniClass 1.0 CSI UniFormat II	BIM/CAD One specific data format No IFC support
Ideal Solution	Generic and manufacturer product-specific data	Industry as a whole (building life cycle)	Unified terms and properties	BIM, model merging and IFC support

The answers to the sent questionnaire indicated that published product libraries combine generic and product-specific information, mainly from the designer point of view, and do not serve product data

management well. In addition, the product libraries in proprietary formats are not linked to any standard specification, e.g. National Building Specification (NBS). The questionnaire responses substantiated that product manufacturers have not yet perceived either the market need or sufficient business justification for advanced BIM-based content creation. Product libraries are constrained to waiting for higher adoption rates of BIM in order to justify the creation of BIM-based product data content. Some product manufacturers are beginning to make BIM-compatible content, but this is a very small percentage of the total content. The integration of product libraries into software applications has not been prioritised in those rare cases either where product libraries exist.

A good product library aims to provide services and solutions to connect people, projects and products across the design and construction industry. The most advanced approaches to resolving product library and product data management issues include intelligent objects, cataloguing tools and data extraction utilities.

Challenges of existing product libraries

Gaps in the completeness of design libraries have been identified in research since the late 1990's (Owolabi, *et al.*, 2003). Three factors are needed for free flow of information: an information exchange format, a specification for information exchange and a standard for what information content is (Bell and Bjørkhaug, 2006). These three established factors allow computerised interoperability between stakeholders.

The issues with product libraries are not just a lack of consistency. Problems related to information integration and interoperability cause the industry to lose 16 billion dollars in the USA alone (Isikdag, *et al.*, 2007). Design teams need accurate product data earlier in the process and contractors need to input their as-built data along the process. Only then are the benefits of data sharing realised in the building life cycle.

The main challenges of developing coherent libraries are not technical. Coherent product libraries for the construction industry have been under development for the past decade (Vanlande, *et al.*, 2008). Despite several projects and efforts, the current state of libraries is still more or less ad hoc, software-specific and design orientated. The successful creation of industry-wide product libraries requires information in a neutral format and content that would be usable in different applications through the process of design-estimation-bidding-procurement-FM.

One of the main problems in the creation of product libraries is the vast number of product categories in the construction industry (Ibrahim, *et al.*, 2004). It is an overwhelming task to define which are the necessary attributes and functionalities of each product type. The second problem is commercial (Ibrahim, *et al.*, 2004), product manufacturers are not interested enough in providing extensive library information because the customers and software developers do not demand them. The product libraries need to become a more viable business case for the information providers. So far, it has not been a desirable business venture for product manufacturers or third-party members of the construction industry.

There are conductive examples of successful implementations of product data management in other industries, e.g. the mechanical engineering industry (Morledge, *et al.*, 2009; Nummelin, *et al.*, 2011). The car, aerospace and shipbuilding industries have been subject to fundamental changes in the implementation of product modelling within the past decades. The major difference between the construction industry and other industrial sectors is the advanced design process in these other industries, which heeds the use and reuse of components during the design process. Assembly line industries also have better supply chain management to their advantage.

BIM-based supply chain management is not common and, in many aspects, is not well known in the construction industry (Taylor and Bernstein, 2009). The complexity of supply chain management in the construction industry is caused by the fragmented nature of the industry that requires its tools to be flexible. The tools used in AEC require features for reuse and configuration of components, either from generic or manufacturer-specific libraries. The car industries' components are designed and made for mass-production and therefore tend to be highly standardised (Owolabi, *et al.*, 2003).

BIM software comprises internal tools that are basically good shape editors with a feature for users to add rudimentary material properties. These built-in software libraries are restricted to only a few aspects of

product usage. Many of the libraries focus primarily on visualisation purposes. Material and presentation attributes support rendering rather than product data management or product life cycle properties. The slow development of coherent BIM libraries has led to a situation in which advanced BIM users have developed design-agency-specific libraries, without concern for the data transfer standards. The nascent IFC-based collaboration makes the lack of standardised product data attributes even more critical. Missing comprehensive material, structural, thermal behaviour, and acoustic performance attributes impact the quality of design when they fail to support their corresponding disciplinary analyses.

Discussion

The need for BIM guidelines

Several countries have their own BIM guidelines. None of the published BIM guidelines actually cover product data management. The only exception is the Australian Guideline, which recognises the need for product libraries and addresses language and classification issues while also referring to the bSDD work (Cooperative Research Centre for Construction Innovation, 2009). In addition to the product data management issues, the document identifies current problems and defines some basic requirements for future product libraries.

The UK Government and abreast clients are now beginning to request or demand BIM. Such demand has been facilitated by the new knowledge created through working parties. The Bew-Richards BIM Maturity Model (Bew and Underwood, 2009) with associated standard, procedures and guides were published by the BSI B/555 Standards Committee in 2011 (British Standards Institution, 2011).

Future trends and risks

This section presents the results of the survey conducted during spring 2011. The identified trends, based on the questionnaire answers, were mainly related to market and process changes. Increasing client demand and use of BIM, especially the growing demand to use BIM in public projects, is identified as a global trend. For example, in May 2011, the UK Government published a construction strategy that requires all public projects to use fully collaborative BIM including all project and asset information, documentation and data as a minimum by 2016. At the same time, the focus is shifting from BIM technology to BIM-based processes. Construction companies and their affiliates are increasing integration between themselves. The importance of information management and coordination is recognised as a strategic issue in the companies. The increasing availability of BIM, as well as growing interest in energy efficiency and other sustainability issues, has an impact on the use of simulations and other analysis.

Based on the BIM experts' answers from the questionnaire, BIM-based supply chain and product data management is currently not a strong trend in industry or research. Construction risk management with BIM was identified as a trend due to the fact that BIM easily visualises problems and errors in designs.
The constantly increasing demand for BIM in public projects seems to be a global trend. The UK government published its BIM demands in May 2011. The demands were followed by detailed steps for establishing requirements. A detailed plan of the roadmap was published in autumn 2011. The UK Cabinet Office has set a goal that requires all public projects to deliver BIM by 2016 (UK Cabinet Office, 2011). Several leading construction companies are demanding BIM from designers in their own projects and often model BIM themselves in projects in which they cannot obtain usable models from designers (Kiviniemi, 2011).

Governmental intervention and public sector involvement

The most recent governmental BIM requirements are from the UK. The UK Government Construction Clients board adopted a BIS/Industry working group and agreed to receive its final report in 2011. The report outlines how government clients can make progressive use of BIM in government building programmes. The report presents a framework for procurement and delivery standards. The report summarises the seven applicable groups of education and support that the construction industry needs in

order to respond to the BIM challenge it is facing. The following work streams may be considered acute for the construction industry (BIS, 2011):

- contracts and legal
- delivery standards
- training and support systems
- COBie definitions
- data management server
- cost-benefit analysis
- communications

Experts imply that national BIM Guidelines need to address the issue of coherent product libraries. Thus, the authorities are starting to create demand for accurate product data and support for BIM-based product data management. Product manufacturers, industry supervising authorities and third-party companies are needed for sponsoring, endorsing, creating and maintaining product library objects containing specification details. Product library objects need to be advised, controlled and checked before uploading to open BIM libraries. Public service providers have the potential to become generators and custodians of public product libraries.

There are several positive aspects of the public sector's greater involvement. The public sector is able to conform to an accepted local classification system; it has the resources to support performance-based specification and the reserves for monitoring by standardisation. There is a vast need for professionals who can supervise the use of parameters and filter sets, provide answers to questions from the industry, check the pacifiers against project briefs, and elaborate what needs to be changed after model checking.

The UK Government and major clients are now beginning to request BIM. Such demand has been facilitated by the new knowledge created through working parties. The BSI B/555 Standards Committee has released a BIM maturity diagram with an associated standard, procedures and guides (B/555, 2011).

Legal issues

The questionnaire did not disclose any legal risks of using integrated BIM. However, in May 2011 Engineering News-Record published an article stating that *"a lawsuit over construction of a life-sciences building at a major university stands as the first known claim related to the use of building information modelling by an architect. Furthermore, the claim and its settlement serve as a cautionary tale to others using BIM, says the insurer."* (Post, 2011). The building industry is decelerating development due to uncertainties with legal and business aspects while the technological readiness of BIM expands to new applications (Holland, 2010; McAdam, 2010; Sebastian, 2010; Greenwood, *et al.*, 2010; Ashcraft, 2008; Gralla, *et al.*, 2009; Sebastian, 2011). Based on current information, it is difficult to evaluate what impact this case will have on the use of BIM in the US markets. Regardless, it is clear evidence of the demand to develop new working and contractual models that define the roles and responsibilities of the partners as well as the status of BIM as a project document.

Training and implementation of BIM processes

Future development focuses strongly on identified risks related mainly to general issues. The adoption of BIM struggles with very trivial issues: poor or missing training is slowly being amended as the next generation of designers enters the market; low quality of models regarding the integrated use in projects is under evaluation and is gradually improving through increasing understanding by designers as well as better interoperability of software and product libraries. The inability to implement BIM-based processes both inside and between companies, as well as the contractual and liability issues, must be resolved through more open collaboration. The question of proprietary vs. OpenBIM is a possible risk from a technology point of view. The juxtaposition of the two possibilities could potentially delay the adoption of BIM as it creates uncertainty in the markets. The slow transition from research into products and mass use in the industry is identified as a risk.

Storing data in building information models and the coherency of product libraries

Based on the answers, one ideal use of BIM in the bidding and procurement process could be as a central definitive information repository. The as-designed native models could take preference over any conflicts. Native models could function as a platform from which the required information is extracted by different viewer and downstream applications. For security reasons, the viewer applications need their own highly collaborative information databases to manage information during the bidding and procurement phase. For procurement purposes, a more widely shared BIM should be available. The shared BIM should support construction processes, payments, versioning, and progress into the as-built model for handover to the FM team.

Coherent product libraries require support for code compliance software and e-commerce. Much of the data provided by contractors could come directly from product manufacturers (East, 2012). The product libraries need to be web service-based in order to be open and accessible. Coordination, tendering, ordering, tracking, delivery, installation, progress payments, and maintenance requests are just a few features of future BIM-compliant product libraries. The flow of the BIM-compatible product library process is presented in Figure 2.

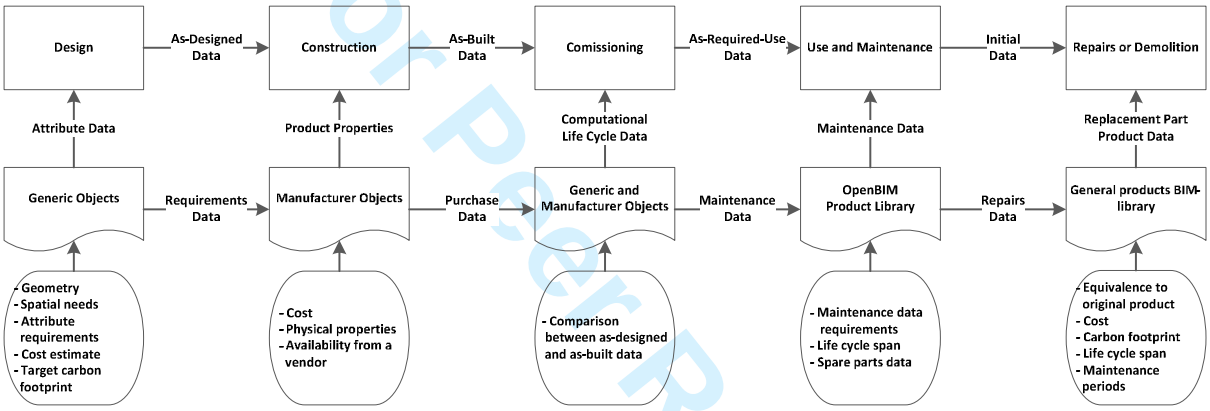

Figure 2. BIM Compatible Product Library Process

New tools

One interesting, but less visible, trend in BIM is the new emerging tools. The possibility of coming up with rapid alternatives and conducting analysis at the very early stages of the project is called optioneering. Optioneering is a term increasingly used in the industry when management needs to be confident of a course of action; particularly when regulatory or funding bodies seek a demonstration of due process.

On-going international research covers several topics, for example, how to deliver applications that rely on the OpenBIM idea, integration of reference documents with models for accessing supporting information for electrical trades, support for product discovery, development of a method for evaluating life cycle cost and performance of systems for sustainability, and documenting the processes and procedures for using bSDD and communicating its uses and benefits (Grant, 2011).

There is on-going development work in Norway and the US to review and adopt the Norwegian product terms for use in North America (Grant, 2011) and define equipment types and key properties to support government agencies that use bSDD in maintenance management. In the USA the aim is to expand the term “library” to support IFC model exchanges between manufacturers, software companies and industry organisations (Stangeland, 2001).

Conclusion

There are predictable and obvious matters related to BIM-based PDM, but this study can better enable understanding of certain issues. The industry is encouraged to put effort into creating an interoperable

single source product database for any BIM software from different vendors. Interoperability is one of the key elements in the development and commissioning of product data management. Interoperability is important to BIM due to its capability to allow data exchange between different programs via a common set of business procedures, same file formats and software protocols while covering the whole building life cycle as well as considering the needs of different shareholders.

Among the most advanced software-specific libraries known by the research team are applications that include extensive coverage of commercial products in their market areas. These programs for product databases cover both product data attributes and functional properties of real products. It is still a relatively unusual feature in BIM software for objects to be dynamic parts of building systems. Research on product data management in BIM becomes useful to the industry when the results are adopted by commercial software vendors as part of their products and by product manufacturers as their information supply platform.

Openness between all parties and clear identification and publication of the requirements for tools are needed to achieve the goal. The use of a neutral file format like the IFC for data exchange or bSDD for data storage could serve a wider audience, though it might limit the responsiveness to the iterative nature of design. The receiving applications would need to be able to support “model merging” with IFC data for this to work. This is not a widespread capability. The joint evaluation of existing solutions and tools provides a common starting point for the development of new instruments and determining future research activities. Participation by all interested parties from software and hardware industries, research institutes and the construction industry is most welcome.

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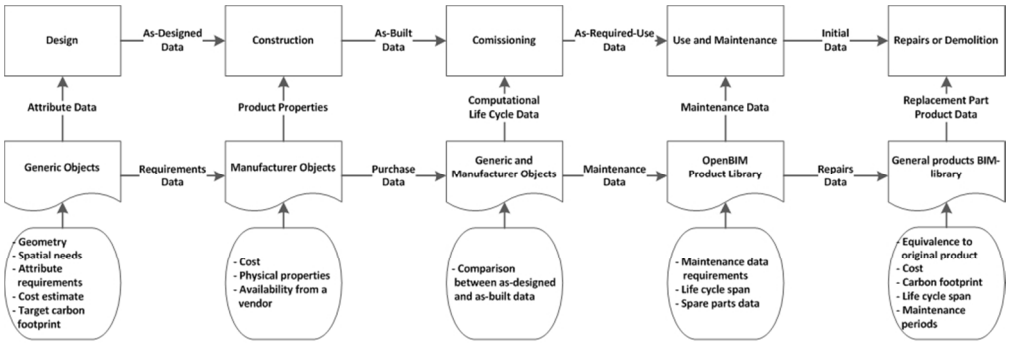
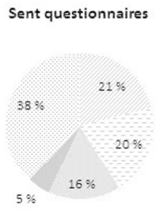
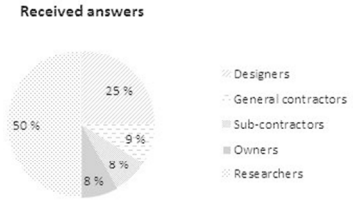


Figure 2 BIM Compatible Product Library Process
215x72mm (120 x 120 DPI)



Sent questionnaires
254x190mm (96 x 96 DPI)



Received questionnaires
254x190mm (96 x 96 DPI)